BIOMECHANICAL ANALYSIS OF A LONG-DISTANCE RUNNER WHO FINISHED 100 MARATHONS IN 100 DAYS

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Introduction

Multi-stage running challenges can be completed by an individual that is incredibly gifted and motivated.[1] An extraordinary long-term running performance may benefit from low dynamic loads and a high load-bearing tolerance. An extra-ordinary runner scheduled a marathon-a-day for 100 subsequent days.[2] His running biomechanics were investigated to better understand successful long-term running in the master athlete. Compared to a normative group of distance runners matched by foot strike pattern, we expected relatively low external loads in the successful high-mileage runner without major changes in these running kinetics during the 100-day period.

Methods

The marathoner (male, age: 55 yr, body height: 1.81 m, mass: 92 kg) initiated a marathon-a-day challenge for 100 consecutive days at a comfortable running speed. Overground running gait analysis was conducted before the marathon-a-day challenge and near its completion. The case's running biomechanics, with special attention to kinetic parameters associated with running-related injury, were compared pre-challenge to thirty-one runners (male:21, female:10, 1.74 ± 0.08 m, 68.2 ± 8.6 kg, 29.9 ± 9.2 yr.; self-reported running volume: 30 km/week) who were matched by a similar foot strike pattern.[3] The marathoner's values were compared to the normative group by the Bayesian Test for a Deficit allowing for Covariates.[4] The Wilcoxon signed-rank test was used to compare the force characteristics between the pre- and post-running sessions in our Sport Science Laboratory-Jacques Rogge.

Table 1: . The case-controls comparison. * indicates $p < 0.05$.

Variable	Controls		Case	Significance test
	Conditional mean	SD	Mean	P
GROUND REACTION FORCE CHARACTERISTICS				
Peak vertical force (BW)	2.57	0.18	2.19	0.025*
|Peak braking force| (BW)	0.383	0.054	0.265	0.023*
Peak vertical loading rate (BW/s)	109.0	28.9	47.1	0.026*
SPATIO-TEMPORAL				
Step frequency (Hz)	2.71	0.11	2.74	0.802
Step length (m)	1.23	0.05	1.21	0.771
Contact time (s)	0.249	0.015	0.293	0.004*
Flight time (s)	0.118	0.018	0.071	0.009*
Duty factor	0.34	0.02	0.41	0.002*
TOUCHDOWN KINEMATICS				
Foot angle (°)	20.7	4.8	29.5	0.045*
Vertical velocity foot (m/s)	1.22	0.10	0.87	0.002*
JOINT WORK				
|Knee eccentric| (J/kg)	0.730	0.122	0.395	0.014*

Results and Discussion

Running gait mechanics

The comparison of the case to the controls is summarized in Table 1. The case's peak vertical ground reaction force ($\Delta\bar{x}$=-0.38 BW, -15%), peak vertical loading rate ($\Delta\bar{x}$=-62 BW/s, -57%), and peak braking force ($\Delta\bar{x}$=-0.118 BW, -31%) were remarkably lower ($p_1<0.05$) than the control group at ~3.3 m/s. We have attributed the relatively low loading-related magnitudes to a remarkably high duty factor of 0.41 at the evaluated speed.[2] The foot strike angle of the marathoner was much greater than that of the control group, which can affect the peak vertical loading rate.[2] The negative work at the knee was also remarkably less in the case (Table 1). Willy et al. have suggested that less eccentric joint work at the knee may be beneficial in runners who are recovering from injuries to the quadriceps mechanism and in runners with patellofemoral and tibiofemoral joint osteoarthritis.[5]

The marathon-a-day challenge

A marathon-a-day was run for 100 consecutive days. The daily laps were completed at an average speed of about 2.64 m/s and the self-reported average finish time was 4h30. The case declared good health status in the final week of the challenge. The force characteristics of the marathoner did not change significantly over time (range in p-values: 0.313 - 0.625), which points to a loading pattern that has become motorically grinded after years of high-volume training. The high-mileage marathoner has now completed a total of 1000 marathons in his sportive career, which shows a high load tolerance in the case.

Significance

We present a distinct biomechanical profile of an extraordinary high-mileage runner, who successfully finished 100 marathons in equal days and had relatively low running ground reaction forces. The remarkable pattern of the high-mileage runner may be useful in the development or the evaluation of load-shifting strategies in distance running. For instance, running with a very pronounced rearfoot strike angle and a high duty factor (i.e., long contact and short flight times).

References

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